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The Scientific Self-Literacy of Ordinary People: Scientific Dialogic Gatherings

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Abstract

In the last decade, researchers have responded to a social demand for science to become more responsible and have a greater effect on society by looking for innovative ways to link science and lay people. The movement to democratize expert knowledge is growing. This movement is creating tools that are used for improving the scientific literacy of citizens. This article presents dialogues between researchers and lay people of low socioeconomic status and low educational level on the social impact of a Scientific Dialogic Gathering (SDG) as a tool for promoting scientific self-literacy that is being developed at an urban adult school in Spain. Based on a communicative and qualitative approach, an SDG encourages people of low socioeconomic status and low educational level to learn about the latest scientific breakthroughs on issues that interest them, such as health-related topics. Participants in a SDG, together with researchers and educators, discuss scientific articles in an egalitarian dialog. One of the main results of this experience is that SDGs are helping lay people to make better decisions in the face of the challenges of today's society.

Keywords

scientific dialogic gathering, adult education, science education, scientific literacy, vulnerable groups

In the last decade, researchers have responded to an increasing social demand to render science more socially responsible by having a deeper impact on society at large and by establishing innovative links between science and lay people (Antonakis, 2017; Bauer, 2009; Price & Peterson, 2016). In the Horizon 2020 Research Program of the European Union, this demand has materialized in the Work Program of Science with and for Society with the aim of building an effective cooperation between science and society. This program aims to influence society in several areas, among them the integration of science and innovation into social learning, the introduction of formal and informal science education, and the making of scientific knowledge accessible to the public, thereby helping to overcome the challenges faced by society (Owen et al., 2012; Valero-Matas et al., 2017).

Robert Merton (1973), the founder of the study of sociology of science, already emphasized that scientific knowledge must be considered as public knowledge and has to be communicated to the general public rather than remain in the confines of the scientific community. Both citizens and researchers have increasingly developed innovative and inclusive tools that are used for the scientific literacy of lay people. This trend responds to what has been defined as the democratization of expert knowledge (Beck et al., 1994).

This effort to build bridges between science and society is founded on the notion that scientific knowledge has a positive social impact. It has been clearly demonstrated that access to education and scientific knowledge is associated with better health, the empowerment of citizens, and active participation in public affairs, fostering a more engaged citizenry and improving employability (Rudolph & Horibe, 2016; Silk et al., 2012). More and more ways have been proposed for citizens to have access to the latest advances in scientific and technological knowledge (Science Europe, 2013; Willinsky, 2005). There are numerous initiatives by different organizations, such as associations, schools, museums, and non-governmental organizations (NGOs), to promote access to science in various attractive ways. Many of these initiatives not only provide citizens with access to knowledge but also aim to empower them through social learning (Zerai et al., 2017). These social approaches to science learning facilitate the exchange of knowledge, joint learning, and co-creation of knowledge by interested people who share a common purpose. To do so, interactive spaces of joint work have been created where this knowledge is accessed and shared

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through dialog and reflection, which leads to action and a change of attitudes (Kristjanson et al., 2014).

In these spaces of dialog between science and society, the conversation begins with collaborative inquiries that involve people as active agents of their own scientific learning, promoting necessary skills to engage in science-related civic issues (Duran et al., 2016; Jack et al., 2017). From this perspective, it is helpful to identify problems and discover solutions by developing an in-depth understanding of the impacts of science on people's lives and on society at large (Brady et al., 2016; McNeill, 2011; Sadler, 2004) around issues of common interest such as modified foods (Walker, 2003), energy choices that contribute to the reversal of climate change (Schweizer & Kelly, 2005), or the dangers of mobile phones (Albe, 2005).

Innovative links between science and the general public have also affected work done in recent years in creating indicators for evaluating the social impact of science (Flecha et al., 2015). Recent contributions stress the importance of creating social dialog spaces involving citizens in the evaluation of that social impact (Aiello & Joanpere, 2014). A qualitative inquiry using a social dialog can provide a deeper knowledge of the social impact of science. Such an inquiry is one way to carry out responsible qualitative research on the social impact evaluation.

This article describes the progress of knowledge in this field. We put together researchers and lay people with low socioeconomic status and low educational level to discuss the social impact of science on society using a Scientific Dialogic Gathering (SDG). SDGs are a tool of scientific self-literacy that have been developed in an urban adult school in Spain. SDGs encourage people with low socioeconomic status and low educational level to access scientific breakthroughs on issues that interest them, such as health-related topics. We describe what SDGs are and how they are carried out at that adult school. Thereafter, we discuss how dialogs between researchers and participants in SDGs have been used to qualitatively assess the social effect of SDGs. Finally, we discuss some of the social impacts of SDGs.

SDGs in a Working-Class Neighborhood

Dialogical gatherings provide a space for the collective creation of knowledge based on a dialog among and a joint reflection of participants. These dialogs and joint reflections arise from reading the best works in literature, art or science (García-Yeste et al., 2018). This case focuses on a SDG that occurs at a school of adult education in a working class neighborhood of Barcelona. This school was the very first to create dialogic gatherings in 1980 (Aubert et al., 2016). Currently, dialogic gatherings are an educational and cultural movement that has spread throughout the world (Soler, 2015). This educational action has been previously studied by identifying its effects on the improvement of academic results, the promotion of values, and the fostering of emotions and feelings that contribute to a greater social cohesion (García-Yeste et al., 2017).

In an SDG, the best works of scientists throughout history are read. In the SDG at this adult school, participants have read works such as "Letter to Grand Duchess Christina" by Galileo and "De rerum natura" by Lucretius. They also read scientific articles published in prestigious journals such as *Nature*. The selected scientific articles involved subjects chosen by the participants related to such topics as general health and diet linked to a lower risk of cognitive decline, obesity, neuroscience, and healthy brains, as well as to environmental and sustainable development topics such as ocean warming, climate change and water policy, and science versus political realities.

About 15 people participated in this SDG, depending on the day, both men and women, although the majority was usually women. The participants were diverse in terms of age, cultural origin, and academic level, but none of them had a university degree. In the gathering at this adult school, there were women who took literacy classes, young people who failed at their previous school, immigrants or refugees who came to prepare for an academic degree or to learn Catalan or Spanish, as well as retired working class men. The type of people participating in the SDG is one of the factors that clearly bridge the existing gap between science and society. Scientific knowledge is often inaccessible to society at large but more so to the most disadvantaged groups, such as those with little academic background.

The SDG occurs once a week over a 2-hour session that encourages everyone to participate. Currently, the sessions are held on Wednesdays at 19:00. Before the meeting, the participants choose a reading topic, and a committee of participants, guided by the educator, are responsible for selecting a specific article. The team of educators ensures that the participants can access a translated version of the article. The article is distributed free of charge both on paper and digitally, according to each participant's preference. In the meeting, the participants have already read the article at home and selected a paragraph. During the conversation, each participant reads his or her selected paragraph and explains why he or she selected it. Participants' explanations reflect their own way of life. Through the dialog and the shared reflections emerging from the reading of the selected paragraphs, the participants are discovering the necessary meaning and knowledge that are useful for their own daily lives, their families, their communities and society in general. The educator is assigned with the task giving their turn to talk freely.

Currently, this school operates this science education activity with adult education NGOs from Germany, Greece, and Slovenia within the framework of the ScienceLit project: Scientific literacy for all (2016–2018), funded by the ERASMUS + program of the European Commission.

Qualitative Assessment of the Social Impact of SDGs

This article includes a qualitative assessment of the impact of SDGs on the lives of four of their participants: Luisa, Teresa, Silvia, and Marta. Their ages range from 55 to 70 years.

Different methodologies are required to carry out an in-depth analysis of the social impact of an educational program. The analysis of impact has a long-standing tradition of using quantitative methodologies but it results somewhat problematic especially in the case of social impact (Reale et al., 2018). However, a qualitative analysis that goes further and provides knowledge about the impact of a program like this on the daily life of people is absolutely necessary. Therefore, in this study, we formed a discussion group with people participating in an SDG in which an egalitarian dialog has been established between the participants and the researchers. This dialog began with a joint reflection and exchange of knowledge between researchers and participants on innovative links between science and society, the role of science education, and other related topics. The participants discussed how the SDG is having an impact on their lives. Thus, both parties developed the necessary knowledge that responded to qualitative inquiries such as which items of the SDG facilitated access to the results of the investigation; how do participants choose the topics to be read; how have the participants overcome barriers to understanding the materials read; how have these joint readings affected the participants' and their families' decisions about health, food, energy consumption, and participation in other related activities; and in what way have the participants' lives been improved after taking part in the SDG sessions.

Impact of SDGs on Participants' Daily Lives

Overcoming the Difficulty of Common People to Access Scientific Knowledge

According to scientific literacy studies, poor levels of reading are usually associated with poor health and misuse of medical services, regardless of the number of schooling years (Berkman et al., 2004). Therefore, a key objective of scientific reading is to overcome socioeconomic barriers, thus contributing to social transformation and improvement of the quality of people's lives (Molina, 2015; Soler, 2015). SDGs are helping people with low educational level to read articles and scientific works of the highest quality. In this way, SDGs help overcoming the reproductive perspectives that did not consider the possibility for certain social sectors to understand cultural elements of high elite (Bourdieu, 1979). That is how SDGs undermine social determinisms and help vulnerable groups, which are excluded from society due to prejudices and the false notion that they are not interested in improving their education (Llopis et al., 2016).

In an SDG, there is both a dialog and a joint reflection on these readings, which helps the participants to overcome the difficulties of reading and understanding a scientific text. However, it goes beyond that. Collective knowledge is created in this process of dialog and joint reflection. As a result, participants are increasingly motivated and curious to learn more and to broaden their understanding of different topics, which they would otherwise not be able or inclined to do.

Next, Luisa and Teresa explain that despite their initial fear, they soon became motivated to learn more about the topics discussed. They are seeking the information they need on their own, either to understand concepts that appear in the article or to deepen their knowledge of a topic. The information gathered by Luisa and Teresa either at their homes or at the computer room of the school is shared and discussed with their peers in the chat room. This joint dialog helps everyone achieve a better understanding:

> LUISA: At the time of receiving the text, when you read it for the first time, you say "dear me . . . I understand nothing." We read an article about DNA genetics and truly it was like "I cannot read it." But of course it encourages you to look up for things and to move on and find out more. For me, it was ideal to go to the internet and search for the meaning of many words that were unknown to me. It comes in handy because it forces you to learn more or to search further about a number of topics.
> TERESA: To me, the truth is that when I was asked to join this program, I saw it a bit like "Oh my godness, a scientific session!" How would I go for a scientific gathering when I know nothing what so ever about scientific matters? . . . So, I have learnt new things that I thought I would not be able to learn, that I had never done before. Now I know many things about the scientific world. As they said, readings are sometimes difficult but with tenacity we manage to understand them . . . In addition to reading the pre-selected text, we have also been searching for information ourselves. Participating in the SDG thus provided an opportunity to find information that you might not have looked for otherwise.

Fostering Analytical and Critical Thinking Based on Scientific Evidence

SDGs are honing analytical and critical thinking based on scientific evidence. Luisa explains that through the SDG, she has learned to select scientific information. Independently reading articles published in journals recognized for their scientific prestige has taught the participant to sift through the massive amount of information on the internet based on whether or not it is corroborated by scientific evidence. Luisa says that she knows now that these articles have been scientifically proven and that she knows now how to identify whether other types of articles are based on scientific evidence. Echoing Luisa's thoughts, Teresa explains that

reading scientific articles has helped her to become more critical about the scientific information she reads elsewhere, such as in newspapers:

> LUISA: The type of articles published in prestigious journals by the scientific community is a different thing altogether [from newspapers articles]. These articles, unlike newspapers, are completely reliable. On the internet, there is a lot of information, and you have to know how to search for accurate information.
> TERESA: Then one becomes more critical. If you have read a scientific article and you have been discussing it at the social gathering; and then you read something in a newspaper that resembles but [you see] that there is no source or that it is not completely [rigorous with] what you have read. Well, then you become more critical. You think, well, this article has been done by taking out a paragraph [from a scientific source] but then it was written at their discretion.

Contributing to Acquiring a Rigorous Understanding and Use of Scientific Knowledge in Decision-Making

SDGs, in line with findings of previous studies on the impact of scientific literacy, provide great benefits to people's lives. For example, SDGs facilitate access to tools and information about disease prevention and detection (Hazelkorn et al., 2015). Therefore, participants in an SDG are acquiring a rigorous understanding of and the ability to use scientific knowledge in making decisions about various aspects of their and their families' lives. The knowledge acquired in these gatherings helps participants to make decisions regarding changes to their eating habits by opting for healthier options. Silvia, one of the participants in the SDG, explains how by reading an article about nutrition, she came to understand why not all foods have a positive influence on the brain and accordingly how a healthier diet, together with physical exercise, greatly contributes to a healthy brain:

> SILVIA: At first, one thing, for example in the food article that we read. I do think food is good for the body. It is healthy, and all the stuff about that, no? But in itself, in the article, they specified very well why, and their reasons for it. If you have a healthy diet and exercise, your heart pumps well and there is less fat in the system. Our brain works much better because it receives more blood, more oxygen.

Promoting Solidarity and an Active Citizenship Facing the Challenges of Today's Society

SDGs are not only helping participants to make decisions that can have an impact on their lives or those of their families, but they also help to achieve a deeper collective knowledge on economic and social issues that are related to science and the cure of diseases. For instance, after reading and discussing one of the articles, Silvia clearly understood why Alzheimer's disease is triggered. She had heard about it on TV debates, but it was not until she read and discussed a scientific article in an SDG that she understood the specific challenges hindering the development of a cure to this disease and what are the interests of pharmaceutical companies in finding such a cure:

> SILVIA: As for Alzheimer's disease, for example, when you hear about it on TV, it is hard to know that there is a fight to cure it . . . it is hard to understand the interests of pharmaceutical companies to develop curing medicines . . . they do not explain it clearly. But when we read the scientific article, we were able to discuss these topics.

A dialog among participants is fundamental. This dialog is not intended to impose the point of view of one of the participants on other participants. Silvia explains how the dialog she had with one of her colleagues on the subject of Alzheimer's disease and pharmaceuticals completely changed her views about this topic. We can identify in the words of Silvia the Habermas perspective of the theory of communicative action by which everyone is capable of language and action, thereby establishing a dialog with valid arguments (Habermas, 1984).

Learning to listen to others and to reach agreement based on argument is one of the skills that the literature on scientific education has identified as fundamental to foster an active citizenry capable of collaborating and taking collective initiatives (Jack et al., 2017):

> SILVIA: (regarding the article on a healthy brain) I remember that there was a participant who made me completely change my mind. I had an idea, and then another (woman) explained her views on the matter. So, since then I said it's true; it also makes you think that you're not the one who's right either.

Marta and Silvia explain how, as a result of participating in the SDG, they have become more alert to scientific topics related to their daily lives. In line with the findings of previous studies on the impact of scientific education (Rudolph & Horibe, 2016), SDGs are helping participants to become active in facing the challenges of our society as well as promote a stronger solidarity among citizens. Marta says that she has previously not noticed these issues. Silvia thinks that she has also been enriched as a person; for example, gaining a deeper understanding of Alzheimer's disease has led her to better understand a person who has that disease and, consequently, to act in a different way:

MARTA: I think that this is more useful for us, yes, because even when I do my day-to-day things, I now pay more attention. Before [learning about scientific information related to daily life], I took no notice at all.
SILVIA: On the one hand, you get more interested in these issues. I believe that this always enriches your own way of thinking. On the other hand, for example, at times, I better understand when you read an article on the Alzheimer's disease. I may have understood the problem in a more appropriate way rather than someone who could have created it and, maybe, you can act differently.

Conclusion

Through discussions with women participants in an SDG, it has been possible to explore the impact of this program on the women's lives. Built on a dialog among researchers and participants, an SDG is an innovative way to introduce science to lay people. The principles on which SDGs are based empower people without academic education to read scientific articles. The egalitarian dialog and the joint creation of collective knowledge that occurs in SDGs have a positive impact on the lives of the participants. Participating in SDGs leads not only to understanding scientific texts but also creates useful knowledge that helps the participants in making decisions about different aspects of their lives, such as choosing healthy eating habits. Participating in an SDG has also helped the participants to distinguish between scientific information and other types of information that appear as scientific but are not backed by evidence. SDGs have become a tool of self-literacy, cultivating analytical and critical thinking and promoting an active approach in facing the challenges of today's society.

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